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[Translator note: A bracketed word in the text is added by the translator in order to make the meaning clear.]

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[TN: A word with an asterisk can be read differently due to nature of Japanese.]

(54) **[Title of the invention]**

A method of polishing wafers and a device therefor

(57) **Abstract**

[Purpose]

To provide a method of polishing wafers and a device that permits determining the thickness of a film that is being polished without removing the wafer from the surface plate in the middle of polishing and that permits efficient performance of highly accurate polishing control.

[Constitution]

In a method in which a wafer (7), secured to a wafer supporting plate (8) and while being rotated by the wafer supporting plate (8), is pressed to polish against the surface of the rotating surface plate (1) on which a polishing cloth (5) is glued while dripping polishing liquid, such polishing is performed by determining the polishing condition by observing the light reflection state of the polishing surface of the wafer (7) using an imaging device that uses a charge coupled element, a device to display that image and a spectral reflection factor measuring device, through a clear window (4) that is created between the rotation center of the surface plate (1) and polishing cloth (5) and the periphery.

[Claims]

[Claim 1]

In a method in which a wafer, secured to a wafer supporting plate and while being rotated by the wafer supporting plate, is pressed to polish against the surface of the rotating surface plate on which a polishing cloth is glued while dripping polishing liquid, such polishing is performed by determining the polishing condition by observing the light reflection state of the polishing surface of the wafer, through a window that is created between the rotation center of the surface plate and polishing cloth and the periphery.

[Claim 2]

A method described in Claim 1 in that the light reflection state is observed using an imaging device that uses a charge coupled element and a device to display that image.

[Claim 3]

A method described in Claim 1 in that the light reflection state is observed using a spectral reflection factor measuring device.

[Claim 4]

A wafer polishing device that is equipped with: a surface plate that rotates by a rotating device; a polishing cloth glued on the surface of the surface plate; a wafer supporting plate that faces the polishing cloth [placed] between the center of the surface plate and its

periphery, placed so as to be movable in the axis direction, and that is rotated by a rotating device; a groove created extending in the radius direction on the surface on which the polishing cloth is glued between the center of the surface plate and its periphery; a polishing cloth window created on the polishing cloth matching with the groove; a through-hole created in the groove of the surface plate; a clear window that closes the through-hole; a probe that is placed at the opposite side of the face having the groove on the surface plate and facing the rotating path of the through-hole and that irradiates light on the polishing surface of a wafer, secured to the wafer supporting plate, through the above described clear window and that receives that reflected light; an optical cable connected to the probe; a device to supply light to the optical cable connected to the optical cable, and; a device to observe or evaluate reflected light.

[Claim 5]

A wafer polishing device that is equipped with: a surface plate, made of a clear material, that rotates by a rotating device; a polishing cloth glued on the surface of the surface plate; a wafer supporting plate that faces the polishing cloth [placed] between the center of the surface plate and its periphery, placed so as to be movable in the axis direction and that is rotated by a rotating device; a groove created extending in the radius direction on the surface on which the polishing cloth is glued between the center of the surface plate and its periphery; a polishing cloth window created on the polishing cloth matching the groove; a probe that is placed at the opposite side of the face having the groove on the surface plate and facing the above described groove and that irradiates light on the polishing surface of a wafer, secured to the wafer supporting plate, through the above described surface plate and that receives that reflected light; an optical cable connected to the probe; a device to supply light to the optical cable connected to the optical cable, and; a device to observe or evaluate reflected light.

[Claim 6]

A wafer polishing device described in any one of Claims 4 or 5 in that the groove created on the surface plate is a shape surrounded with two adjacent straight lines extending radially from the center.

[Claim 7]

A wafer polishing device described in any one of Claims 4, 5 or 6 in that the reflected light observation device is composed of an imaging device using a charge coupled element and a device to display that image

[Claim 8]

A wafer polishing device described in any one of Claims 4, 5 or 6 in that the reflected light evaluation device is a spectral reflection factor measuring device.

[Detailed Description of the Invention]

[0001] [Industrial Field of application]

The present invention relates to a polishing method for wafers with a film such as semiconductor wafers, especially SOI (Silicon-on-Insulator) wafers, etc.

[0002] [Prior Art]

In semiconductor wafer polishing, a method has been widely used in which: a surface plate, upon whose surface is glued a polishing cloth, is rotated; while dripping polishing liquid on to the polishing cloth, a wafer, secured to a wafer supporting plate, is pressed against the polishing cloth while being rotated by the wafer supporting plate, and; polishing progresses caused by friction between the wafer and the polishing cloth. In this method, usually the amount of polishing is regulated by polishing time under strictly controlled conditions such as surface plate revolution speed, polishing load, amount and temperature of polishing liquid supplied, wafer rotation and oscillation, etc.

[0003]

The average removal rate is obtained from [the relationship between] the amount of reduction of the wafer thickness by polishing and its polishing time, and it is used to determine the polishing time. In ordinary wafer polishing, there is no method other than this method to measure the removal rate. In addition, a fluctuation of the removal rate by a few percent brought about by various conditions did not pose any practical problem, so this method was sufficient.

[0004]

This polishing method is also applied to wafers with film. Compared to ordinary wafer polishing, the allowable fluctuation range of polishing amount is small, so if the amount of polishing is to be controlled by the polishing time, strict process control, in which even a slight fluctuation of the removal rate is not allowed, is required. In this type of polishing, the primary objective is to regulate the film thickness and control of the polishing amount is the only means. The film thickness can be determined by observation of interference fringes with the naked eye or with optical measurement, so in experimental polishing, a general practice is that polishing is occasionally interrupted to confirm the film thickness and determine the time of polishing completion.

[0005]

This method provides a safe method and the least failure, but as a production method, there are many problems. Specifically, such problems are that every time polishing is interrupted, wafer washing and drying is required, so processing time per wafer becomes long and also the mechanism for automation becomes complicated, resulting in higher polishing cost. Furthermore, another problem is that when the time between an interruption and the [next] interruption becomes short, the parameters of such short polishing become different from the polishing parameters at a steady condition, so the expected polishing amount is not obtained and controllability deteriorates.

[0006]

[Problems that the Invention is to Solve]

The present invention is to provide a wafer polishing method and a device that permits determining the thickness of a film that is being polishing without removing the wafer from the surface plate in the middle of polishing and that permits efficient performance of highly accurate polishing control.

[0007]

[Means to solve the Problems]

The means to solve the problems using the present invention are:

(1) In a method in which a wafer, secured to a wafer supporting plate and while being rotated by the wafer supporting plate, is pressed to polish against the surface of the rotating surface plate on which a polishing cloth is glued while dripping polishing liquid, such polishing is performed by determining the polishing condition by observing the light reflection state of the polishing surface of the wafer through a window that is created between the rotation center of the surface plate and polishing cloth and the periphery.

[0008]

(2) the above described method in which the light reflection state is observed using an imaging device that uses a charge coupled element and a device to display that image or by using a spectral reflection factor measuring device.

[0009]

(3) A wafer polishing device that is equipped with: a surface plate that rotates by a rotating device; a polishing cloth glued on the surface of the surface plate; a wafer supporting plate that faces the polishing cloth [placed] between the center of the surface plate and its periphery, placed so as to be movable in the axis direction and that is rotated by a rotating device; a groove created extending in the radius direction on the surface on which the polishing cloth is glued between the center of the surface plate and its periphery; a polishing cloth window created on the polishing cloth matching with the groove; a through-hole created in the groove of the surface plate; a clear window that closes the through-hole; a probe that is placed at the opposite side of the face having the groove on the surface plate and facing the rotating path of the through-hole and that irradiates light on the polishing surface of a wafer, secured to the wafer supporting plate, through the above described clear window and that receives that reflected light; an optical cable connected to the probe; a device to supply light to the optical cable connected to the optical cable, and; a device to observe or evaluate reflected light.

[0010]

A wafer polishing device that is equipped with: a surface plate, made of a clear material, that rotates by a rotating device; a polishing cloth glued on the surface of the surface

plate; a wafer supporting plate that faces the polishing cloth [placed] between the center of the surface plate and its periphery, placed so as to be movable in the axis direction and that is rotated by a rotating device; a groove created extending in the radius direction on the surface on which the polishing cloth is glued between the center of the surface plate and its periphery; a polishing cloth window created on the polishing cloth matching the groove; a probe that is placed at the opposite side of the face having the groove on the surface plate and facing the above described groove and that irradiates light on the polishing surface of a wafer, secured to the wafer supporting plate, through the above described surface plate and that receives that reflected light; an optical cable connected to the probe; a device to supply light to the optical cable connected to the optical cable, and; a device to observe or evaluate reflected light.

[0011]

A wafer polishing device in that the groove created on the surface plate is a shape surrounded with two adjacent straight lines extending radially from the center.

[0012]

The above described device in that the reflected light observation device is composed of an imaging device using a charge coupled element and a device to display that image, or the reflected light evaluation device is a spectral reflection factor measuring device.

[0013]

[Operation]

In the present invention method, when the polishing state is determined by observing the light reflection state of the wafer polishing surface through the window created between the rotation center of the surface plate and polishing cloth and the periphery, the termination point of polishing can be determined without interruption of polishing, so the polishing process time becomes short and the device can be simple.

The light reflection state is determined in such a way: that light is irradiated on the wafer polishing surface using an optical cable; that reflected light is captured by an imaging

device using a charge coupled element (CCD), used in a video camera; this is displayed using an imaging display device such as a cathode ray tube, and; the thickness is determined based upon interference fringes that appeared on the imaging display device. For 2μm or less film thickness, [interference] fringes are observed using an old-type fluorescent lamp or incandescent lamp and for 1μm or less thickness, rainbow-colored fringes are observed.

[0014]

Further, light is irradiated on the wafer polishing surface with an optical cable and that reflected light is taken into a spectral reflection factor measuring device. Based upon the peak of the specific wavelength, one can determine that the thickness becomes the desired thickness. This determination of the polishing state may be performed during polishing or during a temporary stopping of polishing. Even with a temporary stop, the completion time of polishing is extremely short compared to methods of the prior art.

[0015]

In the device of the present invention, reflected light, obtained by irradiating light on the wafer polishing surface through the polishing liquid film formed between the clear window and wafer, is observed or evaluated. Since fine particles are suspended in the polishing liquid and the polishing liquid has a characteristic of scattering light, it is convenient for observation or evaluation if the distance between the surface of the clear window and the wafer polishing surface is shorter.

[0016]

The reason why the groove is created, extending in the radius direction, on the surface of the polishing cloth glued between the center of the surface plate and the periphery, is that if a polishing cloth window is created only on the polishing cloth, there may be a concern of air mixing in the polishing liquid. When air is mixed, observation becomes difficult, so [the groove is created] in order to maintain sufficient polishing liquid and to not allow air to mix in. In order to maintain sufficient polishing liquid in the groove, since the groove and polishing cloth window do not contribute to polishing, a shape that does not

disturb the distribution of the processing amount on the wafer surface needs to be chosen. It is better to surround [the shape] by two adjacent straight lines extending radially from the center of the surface plate to the periphery so that the wafer polishing surface passes in the same time from the center of the surface plate to the periphery.

[0017]

If the shape is as described above, during polishing, when the wafer passes from the compressed polishing cloth, caused by the application of compression load, to the portion of the polishing cloth that is not compressed, the wafer can pass over the recess from the polishing window to smoothly land on the polishing cloth without being caught by the polishing cloth window.

[0018]

The location and shape of the clear window in the groove can be freely chosen. In the case where the wafer center can be used as a representative [thickness] for observation or measurement, the clear window may be located beneath the rotation center of the wafer.

[0019]

When a surface plate is made of a material, such as aluminum, which does not allow light to transmit, as described above, a through-hole is created on the surface plate and the through-hole is closed with a clear window so that the polishing liquid does not leak and light passes through the clear window. When a surface plate is made of a material, such as clear glass, which allows light transmittal, a through-hole and a clear window are not necessary. However, in order to minimize the distance between the wafer polishing surface and the groove bottom, it is better to raise a portion of the groove bottom where light is transmitted.

[0020]

There is no problem with a probe that irradiates light on the wafer polishing surface and receives the reflected light when an observation or evaluation is performed by stopping polishing. However, when an observation or evaluation is to be performed during

polishing and when time is needed to accurately observe or evaluate the specified location of the wafer, since the light transmitting window of the surface plate is rotating and the wafer is also rotating on its axis, the probe only needs to make a reciprocating motion at the same speed as the wafer rotation speed in the same rotating path as the light transmitting window.

[0021]

In the case where a spectral reflection factor measuring device is used for film thickness evaluation, since film thickness can be calculated every measurement, the termination point of polishing can be accurately determined. Instead of calculating film thickness during polishing, calculate in advance the spectral reflection factor when the film reaches the target thickness. When the characteristic of the measured spectral reflection factor matches the calculation, polishing may be stopped.

[0022]

Working examples shown in Figures 1 and 2 are explained. A surface plate (1) is an aluminum disc having a 300mm diameter and a 10mm thickness. A shaft, which rotates the surface plate (1), is fixed at one side of the center. On the other side opposite from the side where the shaft of the surface plate (1) is fixed, there is created a groove (2) that is surrounded by two adjacent straight lines extending radially from the center and that extend close to the periphery from near the center. The width of the groove (2) at the center side is 5mm and the width at the periphery side is 15mm and the depth is 1mm. A through-hole (3) with a diameter of 10mm is created at the center of the longitudinal direction of the groove (2) and conically expands at the opposite side of the groove (2). A clear window (4), made of Pyrex clear glass, is fitted into the groove (2) side of the through-hole (3) to prevent leaking of the polishing liquid.

[0023]

On the face of the surface plate (1) having the groove (2), a 0.7mm thick polishing cloth (5), having the same shape as the surface plate (1) and made of a polyurethane impregnated polyester non-woven cloth, Suba-500 (brand name) that is made by Rodel

[TN: phonetic spelling] Nitta, is glued. The portion corresponding to the groove (2) is cut out in the same shape as the groove (2) to create a polishing cloth window (6). The clear window (4) projects out about 0.5mm from the surface of the surface plate (1), but even with consideration of elasticity of the polishing cloth (5), it is sufficiently lower than the surface of the polishing cloth (5).

[0024]

On the opposite side of the groove (2) of the surface plate (1), facing the rotating path of the clear window (4), a probe (9), which irradiates light on the polishing surface of a wafer and receives that reflected light, is placed. The probe (9) contains a focus adjustment lens inside and is connected to the optical cable (10). The other end is split and connected to a spectral reflection factor measuring device and a measurement light source, which is not illustrated.

[0025]

Two silicon wafers, on the surfaces of which thermal oxidation film is formed, are bonded by having the thermal oxidation films in contact. One wafer was flat surface ground to make a 15μm thick silicon film SOI wafer with a 100mm diameter. The face that is not flat surface ground was glued with wax to the disc-shaped aluminum wafer supporting plate (8), having a diameter of 110mm and a thickness of 10mm, and on one side of which a rotary shaft is fixed.

[0026]

While dripping on the surface of the polishing cloth (5) of the surface plate (1) a polishing liquid made by diluting 20 times NALCO-2350 (brand name), made by Rodel Nitta, composed of an alkaline solution containing silica powder whose particle size is 0.01μm or less, and while the surface plate (1) was being rotated at 50 revolutions per minute and the wafer (7), glued to the wafer supporting plate (8), was being rotated at its own revolution speed of 40 revolutions per minute, the wafer (7) was pressed against the polishing cloth (5) with a polishing load of 10kgf so that the rotation center was located above the clear window (4) to start polishing with a target film thickness of 1μm.

[0027]

Under this condition, the moving linear velocity of the clear window (4) is about 500mm/sec., so the time to be able to measure the center of the wafer (7) through the 10mm diameter clear window (4) is about 10 seconds per one passing. This time was sufficient for spectral reflection factor measurement performed at the wavelength range of 680~800nm and resolution of 1nm. As a measurement reference standard, a silicon wafer placed under the same conditions was used.

[0028]

At the beginning of polishing, the spectral reflection factor of the film showed the same spectrum as the silicon wafer, but as polishing progressed, periodic fluctuation of the reflection factor to the wavelength appeared and gradually its amplitude increased. Individual peaks of the intensity of the reflected light continued to narrow each interval one after another and migrated to the short wavelength side. Due to the shift of the individual peaks, as the peaks in the measured wavelength range were replaced, the intervals of the peaks gradually spread.

[0029]

The calculation shows that the reflection factor of the SOI silicon film with 1μm thickness has peaks at the wavelengths of 700nm and 770nm. Thus, when the position of one peak went below 700nm, the position of the next peak was read and when the reading was 765nm or above, polishing was terminated. When it was less than 765nm, polishing continued while tracking the position.

[0030]

As described above, 10 SOI wafers were polished. As a result, for all the wafers, the center film thickness was within the range of 0.98~1.00μm. The required polishing time was in the range of 30~45 minutes.

[0031] Comparative Example

Under the same conditions as in the Working Example, polishing of silicon film SOI wafers was performed. During the middle of polishing, film thickness measurement was performed by observation as described below.

1. Stop supply of the polishing liquid and after spraying pure water on the polishing cloth, stop rotations of the surface plate and the wafer supporting plate.
2. Pick up the wafers with the wafer supporting plates, rinse them with pure water and drain off water.
3. Observe the wafers by projecting onto the lighted surface light source.
4. Observe the film thickness using the criteria described below.

5a. In the case where polishing is completed, remove the wafer from the wafer supporting plate.

b. When the film thickness is thicker than the target, resume polishing and after the specified time, go back to 1) above.

[0032]

Criteria to determine film thickness by observation of interference fringes

Fringes can be vaguely observed under sodium lamp irradiation → less than 8~10μm

Fringes can be clearly observed under sodium lamp irradiation → less than 5μm

Fringes can be observed under 3-wavelength luminous type fluorescent lamp illumination → less than 3μm

[Fringes] can be observed with an old type fluorescent lamp and incandescent lamp → less than 2μm

Rainbow-color [fringes] under white light (ordinary lighting) → less than 1μm

[0033]

The net polishing time was 30~40 minutes. However, since polishing was interrupted 2~4 times per wafer to measure the film thickness, one hour was spent as an average polishing time. Based upon the results of the film thickness measurement, the time to end polishing was determined using 10 seconds as a unit. Ultimately, the film thickness at the center of the wafers spread in the range of 0.9~1.1μm. Even though the time to

terminate polishing was adjusted shorter than this [10 seconds], the controllability did not improve, so this was assumed to be the limit of polishing accuracy of the prior art.

[0034]

[Effects of the Invention]

According to the present invention, the thickness of a film that is being polished can be determined without removing a wafer from a surface plate in the middle of polishing and highly accurate control of polishing can be efficiently performed.

[Brief Explanation of Drawings]

[Figure 1] is a partial cross-sectional side view of the device of the present invention.

[Figure 2] is a partial plane-view of the surface plate of Figure 1.

[Explanation of symbols]

1	surface plate
2	groove
3	through-hole
4	clear window
5	polishing cloth
6	polishing cloth window
7	wafer
8	wafer supporting plate
9	probe
10	optical cable

Figure 1

【図1】

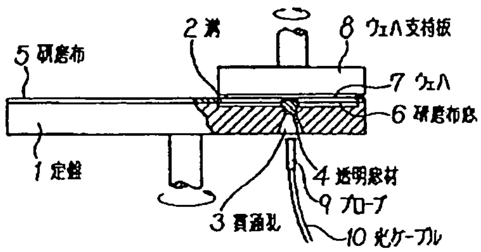
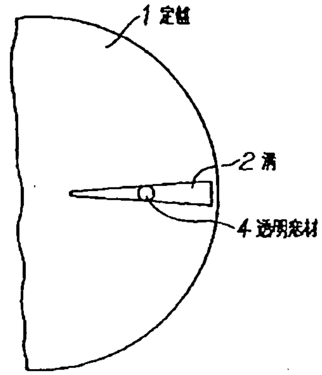


Figure 2

【図2】



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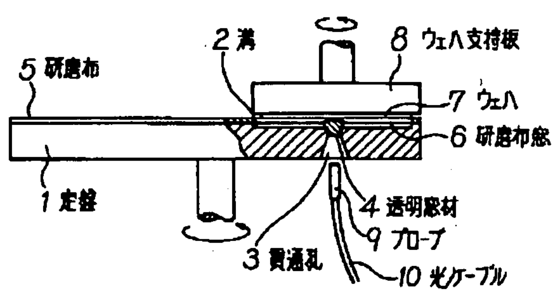
(54)【発明の名称】　ウエハ研磨方法及びその装置

(57)【要約】

【目的】　研磨途中でウエハを定盤から離すことなく研磨中の膜の厚さを知ることができ、研磨の高精度な制御が効率よくできるウエハの研磨方法及び装置を提供する。

【構成】　回転する定盤1の研磨布5の張り付けられた面に、研磨液を滴下しつつ、ウエハ支持板8に固定したウエハ7をウエハ支持板8により回転させせつつ押し付け研磨する方法において、定盤1及び研磨布5の回転中心と周縁との間に設けた透明窓4からウエハ7の研磨面の光の反射状態を電荷結合素子を用いた撮像装置とその撮像表示装置や分光反射率測定装置で見て研磨状態を判定しつつ研磨する。



Roberts EXHIBIT 2060
Roberts v. Birang et al.
Interference 104,424

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【特許請求の範囲】

【請求項1】 回転する定盤の研磨布の張り付けられた面に、研磨液を滴下しつつ、ウエハ支持板に固定したウエハをウエハ支持板により回転させつつ押し付け研磨する方法において、定盤及び研磨布の回転中心と周縁との間に設けた窓からウエハの研磨面の光の反射状態を見て研磨状態を判定するウエハ研磨方法。

【請求項2】 光の反射状態を電荷結合素子を用いた撮像装置とその撮像表示装置によって見る請求項1に記載の方法。

【請求項3】 光の反射状態を分光反射率測定装置で見る請求項1に記載の方法。

【請求項4】 回転装置により回転する定盤と、定盤の表面に張り付けられた研磨布と、定盤の中心と周縁との間の研磨布に対面し軸方向移動可能に配置され、回転装置により回転するウエハ支持板と、定盤の中心と周縁との間の研磨布張り付け面に半径方向に延長して設けた溝と、該溝と一致させ研磨布に設けた研磨布窓と、定盤の前記溝内に設けた貫通孔と、該貫通孔を閉じる透明窓材と、定盤の前記溝を有する面の反対側で貫通孔の回転路に臨ませ配置した、前記の透明窓材を通して光をウエハ支持板に固定したウエハの研磨面に照射しその反射光を受光するプローブと、該プローブに接続した光ケーブルと、光ケーブルに接続した光ケーブルへの光供給装置と反射光観察又は評価装置とを備えているウエハ研磨装置。

【請求項5】 回転装置により回転する透明な材料からなる定盤と、定盤の表面に張り付けられた研磨布と、定盤の中心と周縁との間の研磨布に対面し軸方向移動可能に配置され、回転装置により回転するウエハ支持板と、定盤の中心と周縁との間の研磨布張り付け面に半径方向に延長して設けた溝と、該溝と一致させ研磨布に設けた研磨布窓と、定盤の前記溝を有する面の反対側で前記の溝に臨ませ配置した、前記定盤を通して光をウエハ支持板に固定したウエハの研磨面に照射しその反射光を受光するプローブと、該プローブに接続した光ケーブルと、光ケーブルに接続した光ケーブルへの光供給装置と反射光観察又は評価装置とを備えているウエハ研磨装置。

【請求項6】 定盤に設けた溝が、中心から放射状に伸びる近接した2本の直線に囲まれた形状をなしている請求項4又は5に記載のウエハ研磨装置。

【請求項7】 反射光観察装置が電荷結合素子を用いた撮像装置とその撮像表示装置とからなる請求項4、5、6の何れか一つに記載のウエハ研磨装置。

【請求項8】 反射光評価装置が分光反射率測定装置である請求項4、5、6の何れか一つに記載のウエハ研磨装置。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、半導体ウエハ、特にSOI(Silicon-on-Insulator)ウエハ等の膜付きウエハの研磨方法及び装置に関する。

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【0002】

【従来の技術】半導体ウエハ研磨では、上面に研磨布が張り付けられた定盤を回転させ、研磨布上に研磨液を滴下しながら、研磨布にウエハ支持板に固定したウエハを、ウエハ支持板により回転させつつ押し付けて、ウエハと研磨布との摩擦により研磨を進行させる方法が広く用いられている。この方法において、研磨加工量は通常、定盤の回転速度、研磨荷重、研磨液の供給量及びその温度、ウエハの回転及び揺動、等が厳しく管理された条件下で、研磨時間によって調節される。

【0003】研磨によるウエハ厚さの減少量と研磨時間とから平均の加工速度を求め、研磨時間の決定に用いる。通常のウエハ研磨においては、加工速度の測定はこの方法以外になく、又諸条件の変動がもたらす数％の加工速度の変動は実用上支障がないので、この方法で十分であった。

【0004】膜付きウエハにもこの研磨方法が適用される。通常のウエハの研磨と比較すると、研磨加工量の変動の許容幅が小さいので、研磨時間で加工量を制御しようとすれば、加工速度のわずかな変動も許さないような厳しい工程管理が必要となる。この種の研磨では膜の厚さの調節がその主な目的であって、研磨加工量の制御はその手段に過ぎない。膜の厚さは肉眼による干渉縞の観察あるいは光学的な測定によって知ることが出来るので、実験的な研磨では、研磨を時々中断して、膜厚を確認しながら研磨終了の時期を決めるのが一般的である。

【0005】この方法は失敗の少ない安全な方法であるが、生産のための方法としては問題が多い。即ち、研磨を中断する度にウエハの洗浄、乾燥が必要なため、1枚当たりの処理時間が長く、自動化のための機構が複雑となり研磨費用が高くなる問題がある。又、中断と中断の間の時間が短くなると、定常状態の研磨と条件が異なってくるため、予期した研磨加工量が得られず、かえって制御性が悪化してしまうという問題があった。

【0006】

【発明が解決しようとする課題】本発明は、研磨途中でウエハを定盤から離すことなく研磨中の膜の厚さを知ることができ、研磨の高精度な制御が効率よくできるウエハの研磨方法及び装置を提供することを課題とする。

【0007】

【課題を解決するための手段】本発明による課題を解決するための手段は、

(1)回転する定盤の研磨布の張り付けられた面に、研磨液を滴下しつつ、ウエハ支持板に固定したウエハをウエハ支持板により回転させつつ押し付け研磨する方法において、定盤及び研磨布の回転中心と周縁との間に設けた窓からウエハの研磨面の光の反射状態を見て研磨状態を判定するウエハ研磨方法、

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【0008】(2)光の反射状態を電荷結合素子を用いた撮像装置とその撮像表示装置で見るか、分光反射率測定装置で見る上記の方法、

【0009】(3)回転装置により回転する定盤と、定盤の表面に張り付けられた研磨布と、定盤の中心と周縁との間の研磨布に対面し軸方向移動可能に配置され、回転装置により回転するウエハ支持板と、定盤の中心と周縁との間の研磨布張り付け面に半径方向に延長して設けた溝と、該溝と一致させ研磨布に設けた研磨布窓と、定盤の前記溝内に設けた貫通孔と、該貫通孔を閉じる透明窓材と、定盤の前記溝を有する面の反対側で貫通孔の回転路に臨ませ配置した、前記の透明窓材を通して光をウエハ支持板に固定したウエハの研磨面に照射しその反射光を受光するプローブと、該プローブに接続した光ケーブルと、光ケーブルに接続した光ケーブルへの光供給装置と反射光観察又は評価装置とを備えているウエハ研磨装置、

【0010】(4)回転装置により回転する透明な材料からなる定盤と、定盤の表面に張り付けられた研磨布と、定盤の中心と周縁との間の研磨布に対面し軸方向移動可能に配置され、回転装置により回転するウエハ支持板と、定盤の中心と周縁との間の研磨布張り付け面に半径方向に延長して設けた溝と、該溝と一致させ研磨布に設けた研磨布窓と、定盤の前記溝を有する面の反対側で前記の溝に臨ませ配置した、前記定盤を通して光をウエハ支持板に固定したウエハの研磨面に照射しその反射光を受光するプローブと、該プローブに接続した光ケーブルと、光ケーブルに接続した光ケーブルへの光供給装置と反射光観察又は評価装置とを備えているウエハ研磨装置、

【0011】(5)定盤に設けた溝が中心から放射状に伸びる近接した2本の直線に囲まれた形状をなしているウエハ研磨装置、

【0012】(6)反射光観察装置が電荷結合素子を用いた撮像装置とその撮像表示装置とからなるか、反射光評価装置が分光反射率測定装置である上記の装置、にある。

【0013】

【作用】本発明方法において、定盤及び研磨布の回転中心と周縁との間に設けた窓からウエハの研磨面の光の反射状態を見て研磨状態を判定すれば、研磨を中断せずに研磨状態の終点を知ることが出来るので、研磨処理の時間を短くでき、装置も簡単で済む。光の反射状態は、光ケーブルでウエハの研磨面に光を照射してその反射光をビデオカメラに用いられている電荷結合素子（CCD）を用いた撮像装置で取り、これをブラウン管などの撮像表示装置で表示せしめ、撮像表示装置に現れた干渉縞により厚さを判断する。膜厚の場合、2μm以下では旧型の蛍光灯や白熱灯で縞が見え、1μm以下では白色灯では虹色の縞が見える。

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【0014】又、光ケーブルでウエハの研磨面に光を照射してその反射光を分光反射率測定装置に入れ、特定の波長のピークにより所望の厚さになったことを知る。この研磨状態の判定は、研磨中に行っても、研磨を一時停止して行ってもよい。一時停止しても前記の従来の方法よりも研磨終点までの時間は極めて小さくできる。

【0015】本発明の装置において、透明窓材とウエハとの間にできる研磨液の膜を通してウエハの研磨面に照射した光の反射光を観察あるいは評価するのであるが、研磨液は液中に微粒子が懸濁したものであり、光を散乱する性質をもっているので、透明窓材の表面とウエハの研磨面との間の間隔が小さい方が観察あるいは評価に都合がよい。

【0016】定盤の中心と周縁との間の研磨布張り付け面に半径方向に延長した溝を設けるのは、研磨布にだけ研磨布窓を設けたのでは、研磨液に空気が混じる恐れがあり、空気が混じると観察が困難となるので、研磨液を十分保持できるようにし、空気が混じらないようにするためである。溝に研磨液を十分保持させるため、この溝や研磨布窓は研磨加工に寄与しない領域となるので、ウエハ面内の加工量分布を乱さない形を選ぶ必要があり、定盤の中心から周辺にウエハの研磨面が同一時間で通過するように、定盤の中心から放射状に伸びる近接した2本の直線に囲まれるようにするのがよい。

【0017】このような形状とすれば、研磨中にウエハが圧縮荷重を受けて圧縮されている研磨布上から圧縮されていない研磨布の部分に乗り上げる時に、研磨布窓に引っ掛かったりしないで、研磨布窓よりくぼみを乗り越えて滑らかに研磨布に乗り上げることができる。

【0018】透明窓材の溝中における位置及び形状は任意である。観察または測定をウエハの中心で代表させて良い場合には、透明窓材の位置をウエハの回転中心の下に位置させてもよい。

【0019】アルミニウムのような光の透過しない材料で定盤が作られている時は上記のように、定盤に貫通孔を設けて研磨液が漏洩しないように透明窓材で貫通孔を閉じて光を通過させるようにするが、透明ガラスのような光の通過する材料で定盤が作られているときは、貫通孔や透明窓材を必要としない。しかし、ウエハの研磨面と、溝底との間隔を小さくするために、光を透過させる部分だけ溝底を高くするのがよい。

【0020】光をウエハの研磨面に照射しその反射光を受けるプローブは、研磨を停止して観察又は評価を行う場合は問題はないが、研磨中に観察又は評価を行う場合、定盤の光通過窓は回転しており、ウエハも自転しているので、ウエハの特定場所を正確に観察又は評価するのに時間を必要とするときは、ウエハの自転速度と同じ速度でプローブを光通過窓と同じ回転路において往復運動させればよい。

【0021】分光反射率測定装置で膜厚の評価を行う場

合には、測定毎に膜厚を計算で求めることが出来るので、研磨の終点を正確に決定できる。研磨中に膜厚計算を行わず、膜が目標の厚さになったときの分光反射率を予め計算で求めておいて、測定した分光反射率の特徴が計算と一致した時点で研磨を終了してもよい。

【００２２】

【実施例】図１、図２に示した実施例について説明する。定盤１は直径３００mm、厚さ１０mmのアルミニウム製の円盤で、その中心の片面に定盤１を回転するための軸が固定してある。定盤１の軸を固定した面の反対側の面には、中心から放射状に伸びる近接した２本の直線で囲まれ、中心付近から周縁近くまで伸びた溝２が設けてある。溝２の中心側の幅は５mmで周縁側の幅は１５mm、深さ１mmとなっている。溝２の長手方向中央には、直径１０mmの貫通孔３が設けられ、溝２の反対側では円錐状に拡大している。貫通孔３の溝２側にはパイレックス透明ガラス製の透明窓材４が嵌め込まれ、研磨液が漏れないようにしてある。

【００２３】定盤１の溝２を有する面には、定盤１と同形の厚さ０.７mmのローデルニッタ社製、商品名suba－500ウレタン含浸ポリエステル不織布からなる研磨布５が張り付けられ、溝２に相当する部分は溝２と同形に切り抜かれて、研磨布窓６が形成されている。透明窓材４は定盤１の表面より約０.５mm突出するが、研磨布５の弾性を考慮しても研磨布５の表面より十分低くなっている。

【００２４】定盤１の溝２の反対側には透明窓材４の回転路に面して研磨するウエハ７の研磨面に光を照射しその反射光を受光するプローブ９が配置されている。プローブ９はピント調節用レンズを内蔵し、光ケーブル１０に接続され、その他端は二股に別れ図示していない分光反射率測定装置と測定用光源に接続されている。

【００２５】片面に回転用の軸が固定された直径１１０mm、厚さ１０mmの円盤状のアルミニウム製のウエハ支持板８に、表面に熱酸化膜を形成した２枚のシリコンウエハを、熱酸化膜を接せしめて接着し、一方のウエハを平面研削して厚さ１５μmのシリコン膜として直径１００mmのＳＯＩウエハを、平面研削加工していない面をワックスで張り付けた。

【００２６】粒径が０.０１μm以下のシリカ粉末を含むアルカリ性溶液からなるローデルニッタ社製、商品名NALCO－2350を２０倍に希釈した研磨液を定盤１の研磨布５の表面に滴下しつつ、定盤１を毎分５０回転させな＊がら、ウエハ支持板８に張り付けたウエハ７を、自転速度毎分４０回転で回転させつつ、研磨布５に、回転中心が透明窓材４の上に位置するように、研磨荷重１０kgfで押し付けて目標膜厚を１μmにして研磨を開始した。

【００２７】この条件では、透明窓材４の移動線速度は約５００mm／秒なので、直径１０mmの透明窓材４を通してウエハ７の中心を測定出来る時間は、１回の通過に付き約１０m秒である。この時間は、波長範囲６８０～８００nm、分解能１nmで行う分光反射率測定に対して十分であった。測定の参照基準には、同じ条件に置いたシリコンウエハを用いた。

【００２８】研磨開始時、膜の分光反射率は、シリコンウエハと同一のスペクトルを示したが、研磨の進行に伴い反射率の波長に対する周期的な変動が現れ、徐々にその振幅を増した。反射光強度の個々のピークは相互の間隔を狭めながら短波長側へと移行した。個々のピークの移動により、測定波長範囲内のピークが入れ代わるにつれて、ピークの間隔は次第に広がった。

【００２９】計算によれば、ＳＯＩの厚さ１μmのシリコン膜の分光反射率は波長７００nmと７７０nmにピークを持つ。そこで、一つのピークの位置が７００nmを下回った時点で次のピークの位置を読み、それが７６５nm以上であれば研磨を終了するものとし、７６５nm未満であればその位置を追跡しながら研磨を続行した。

【００３０】このようにして１０枚のＳＯＩウエハを研磨した結果、総てのウエハにおいて中心の膜厚は０.９８～１.００μmの範囲に収まっていた。研磨の所要時間は３０～４５分の範囲にあった。

【００３１】比較例

実施例と同様の条件で同一のＳＯＩウエハのシリコン膜の研磨を行った。研磨途中での膜厚の測定は次のように観察により行った。１.研磨液の供給を停止し、研磨布に純水をかけ流した後、定盤及びウエハ支持板の回転を停止する。２.ウエハをウエハ支持板ごと取り上げ純水でゆすいで水を切る。３.照明に照らされた面光源にウエハを映して観察する。４.下記の目安で膜厚を観察する。５.a)研磨終了の場合、ウエハ支持板からウエハを外す。b)目標より厚い場合は、研磨を再開、所定時間の後１.へ

【００３２】

干渉縞の観察による膜厚判断の目安

ナトリウムランプ照射下で縞がぼんやり見える→８～１０μm以下
〃　　はっきり見える→　５μm以下
３波長発光型蛍光ランプ照明下で縞が見える　→　３μm以下
旧型の蛍光ランプや白熱ランプでも見える　→　２μm以下
白色光下（普通の照明）で虹色を呈する。　→　１μm以下

【００３３】正味の研磨時間は３０～４０分であったが、ウエハ１枚につき２～４回研磨を中断して膜厚測定

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を行ったため、平均の研磨時間としては1時間を要した。膜厚測定の結果を元に10秒単位で研磨終了の時期を決めたが、最終的にウエハ中心の膜厚は0.9～1.1μmの範囲に分布した。又、研磨終了時期をこれより細かく調節しても制御性が良くなることはなく、従来法の研磨の限界精度と考えられた。

【0034】

【発明の効果】本発明によれば、研磨途中でウエハを定盤から離すことなく研磨中の膜の厚さを知ることができるので、研磨の高精度な制御が効率よくできる。

【図面の簡単な説明】

【図1】本発明装置の一部断面側面図である。

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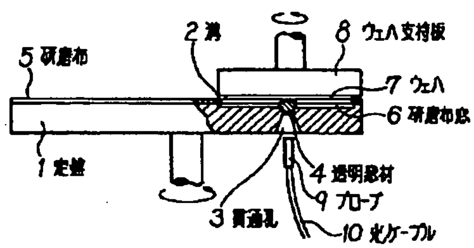
【図2】図1の定盤1の一部平面図である。

【符号の説明】

1　定盤
2　溝
3　貫通孔
4　透明窓材
5　研磨布
6　研磨布窓
7　ウエハ
8　ウエハ支持板
9　プローブ
10　光ケーブル

【図1】



【図2】